UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/727,609	12/01/2000	Jeffrey Kempf	TI-29212	5677

23494 7590 01/26/2006	EXAMINER	
TEXAS INSTRUMENTS INCORPORATED	THOMPSON, JAMES A	
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DALLAS, TX 75265	ART UNIT	PAPER NUMBER
	2624	

DATE MAILED: 01/26/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

	Application No.	Applicant(s)
Office Action Summary	09/727,609	KEMPF, JEFFREY
	Examiner	Art Unit
	James A. Thompson	2624

-- *The MAILING DATE of this communication appears on the cover sheet with the correspondence address* --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE <u>3</u> MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1) ☒ Responsive to communication(s) filed on <u>27 October 2005 and 27 September 2005</u>.

2a) ☐ This action is **FINAL**.   2b) ☒ This action is non-final.

3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4) ☒ Claim(s) <u>1-20</u> is/are pending in the application.

    4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5) ☐ Claim(s) _____ is/are allowed.

6) ☒ Claim(s) <u>1-20</u> is/are rejected.

7) ☐ Claim(s) _____ is/are objected to.

8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9) ☐ The specification is objected to by the Examiner.

10) ☒ The drawing(s) filed on <u>08 February 2005</u> is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.

    Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

    Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

    a) ☐ All   b) ☐ Some * c) ☐ None of:

        1. ☐ Certified copies of the priority documents have been received.

        2. ☐ Certified copies of the priority documents have been received in Application No. _____.

        3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

    * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
    Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413)
    Paper No(s)/Mail Date. _____.

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1.   A request for continued examination under 37 CFR 1.114,
including the fee set forth in 37 CFR 1.17(e), was filed in this
application after final rejection.   Since this application is
eligible for continued examination under 37 CFR 1.114, and the
fee set forth in 37 CFR 1.17(e) has been timely paid, the
finality of the previous Office action has been withdrawn
pursuant to 37 CFR 1.114.. Applicant's submission filed on 27
October 2005 has been entered.

Response to Arguments

2.   Applicant's arguments filed 27 September 2005 have been
fully considered but they are not persuasive.   Examiner does
agree with Applicant that the present amendments to the claims
add limitations to the claims which are not taught by the prior
art cited the previous office action, dated 11 May 2005 and
mailed 27 May 2005.   However, additional prior art has been
discovered which renders the present claims obvious to one of
ordinary skill in the art at the time of the invention.
Accordingly, prior art rejections are given in detail below.

Claim Rejections - 35 USC § 103

3.   The following is a quotation of 35 U.S.C. 103(a) which
forms the basis for all obviousness rejections set forth in this
Office action:

> (a) A patent may not be obtained though the invention is not
> identically disclosed or described as set forth in section 102 of this
> title, if the differences between the subject matter sought to be
> patented and the prior art are such that the subject matter as a whole
> would have been obvious at the time the invention was made to a person

having ordinary skill in the art to which said subject matter pertains.
Patentability shall not be negatived by the manner in which the
invention was made.

4.   Claim 1 is rejected under 35 U.S.C. 103(a) as being
unpatentable over Nguyen (US Patent 5,892,851) in view of
Metaxas (US Patent 6,307,978 B1).

Regarding claim 1: Nguyen discloses a method of performing
error diffusion comprising the step of simultaneously processing
image data for at least two pixels (figure 5(100,500(associated
pixels)) of Nguyen) in a row of pixels (figure 5(510) of
Nguyen), said at least two pixels comprising a first group of
pixels (figure 5(100(associated pixels)) of Nguyen) and a last
pixel (figure 5(500(associated pixels)) of Nguyen) (column 4,
lines 1-7 of Nguyen). A four-weight filter (figure 5(100) of
Nguyen) is applied to all but the last one of the pixels in a
segment of the image row (column 4, lines 6-7 of Nguyen) and a
three-weight filter (figure 5(500) of Nguyen) is applied to the
last pixel in said segment (column 4, lines 4-5 of Nguyen).
Each segment of the image row is computed in parallel (column 3,
lines 55-59 of Nguyen). The image rows (figure 5(510) of
Nguyen) are processed one image row at a time (column 3, lines
18-19 of Nguyen), as demonstrated in the example embodiment in
column 5, lines 35-40 of Nguyen. Since the next image row is to
be processed next, then the last pixel abuts the group of pixels
to be processed next.

Nguyen further discloses reducing the precision of said
image data to produce a modified image data word (column 3,
lines 7-10 of Nguyen) and an error word for each pixel (column
3, lines 5-7 of Nguyen). Since the image is originally a
continuous-tone image and is transformed into a halftone image
(column 3, lines 7-10 of Nguyen), then the precision of said

modified image data is reduced since a halftone image, by
definition, comprises only one bit per pixel and a continuous-
tone image, by definition, comprises more than one bit per
pixel. Error diffusion processing of image data (column 3,
lines 5-7 of Nguyen), by definition, produces an error word for
each pixel based on the difference between the halftone value
and the original continuous-tone value, and then diffuses said
error to other pixels.

Nguyen further discloses propagating a portion of said
error word for each pixel in said first group to two pixels in a
next row of pixels (figure 5(100(associated pixels)); column 3,
lines 21-25; and column 4, lines 6-7 of Nguyen). The four-
weight filter (figure 5(100) of Nguyen) is used for all of the
pixels of the segment except for the last one (figure 5 and
column 4, lines 6-7 of Nguyen). A portion of said error word
for each pixel using said four-weight pixel (first group) is
propagated to two pixels (figure 3(360,370) of Nguyen) in the
next row of pixels, as demonstrated by the error diffusion
arrows of figure 5(100) of Nguyen and the error diffusion propa-
gation shown in figure 3 of Nguyen in which the error of pixel
100 is propagated to pixels **360** and **370**, which are clearly in
the next row to be processed (column 3, lines 21-25 of Nguyen).

Nguyen further discloses propagating a first portion of
said error word for said last pixel to a pixel in said next row
of pixels and a second portion of said error word for said last
pixel to a pixel in said group of pixels to be processed next
(figure 5(500 (associated pixels)) and column 4, lines 1-5 of
Nguyen). Figure 6 of Nguyen shows the three-weight filter
(column 2, lines 53-55 of Nguyen) used for the last pixel of
each segment (column 4, lines 4-5 of Nguyen). Error is propa-

gated from said last pixel into the next row using said three-
weight filter (column 4, lines 1-5 of Nguyen). As can clearly
be seen from figure 5 of Nguyen, the error portions correspond-
ing to figure 6(630) and figure 6(620) of Nguyen (first portion)
are each propagated to a pixel in said next row of pixels and
the error portion corresponding to figure 6(610) of Nguyen
(second portion) is propagated into the first pixel of the
segment below and to the right of said last pixel. The segment
below and to the right of said last pixel is to be processed
next since all segments of a row are processed in parallel
(column 3, lines 55-59 of Nguyen).

Nguyen does not disclose expressly that said group of
pixels to be processed next, which are abutted by said last
pixel, are in said row of pixels.

Metaxas discloses a group of pixels to be processed next
which are abutted by the last pixel of the group of pixels that
are being processed (figure 3; figure 5; and column 4, lines 48-
55 of Metaxas). Error diffusion processing is performed in a
diagonal manner (figure 5 and column 4, lines 48-55 of Metaxas).
Furthermore, a pixel is only processed after all of the pixels
from which said pixel depends have been processed. Thus
(referring to figure 5 of Metaxas), the first pixel of the first
row of A_{K-1} is processed only after the last pixel of the first
row of A_K is processed. Thus, the last pixel of the first group
of pixels to be processed abuts the group of pixels to be
processed next in said row of pixel.

Nguyen and Metaxas are combinable because they are from the
same field of endeavor, namely parallel error diffusion. At the
time of the invention, it would have been obvious to a person of
ordinary skill in the art to combine the parallel processing

method taught by Nguyen with the parallel processing method
taught by Metaxas. Thus combined, the individual area (such as
A_K in figure 5 of Metaxas) would be processed according to the
method of Nguyen while the overall image would be processed
according to the method of Metaxas. Therefore, the length "d"
in figure 5 of Metaxas would be broken into two or more sections
to be processed in parallel, such as shown in figure 5 of
Nguyen. When the last pixel of A_K in figure 5 of Metaxas is
processed, the next group to be processed, which is the first
group in the portion of A_{K-1} on the same row, is processed
according to the method of Metaxas. The motivation for doing so
would have been that the first pixel of the first group in A_{K-1}
cannot be processed until all of the pixels from which said
pixel depends have been processed (column 4, lines 18-20 of
Metaxas), which includes the last pixel of the last group in A_K.
Thus, processing the set of groups in A_K in figure 5 of Metaxas
in parallel (divided in accordance figure 5 of Nguyen) will
speed up the overall error diffusion processing. Since the set
of pixels in A_{K-1} must wait for the last pixel in A_K, if all the
pixels for one row of A_K are processed faster, then the process-
ing of A_{K-1} will occur sooner. Thus, while the processing of A_K
may cause a slight loss of accuracy owing to the fact that the
error between the parallel processed groups (according to
Nguyen) of a single row of A_K cannot be diffused between each
other, this is greatly outweighed by the tremendous increase in
speed. The combined system of Nguyen and Metaxas would be
faster than the system of Metaxas alone, owing to the increased
parallelism, and more accurate than the system of Nguyen alone,
owing to the propagation of error diffusion between areas such
as A_K and A_{K-1}. Therefore, it would have been obvious to combine

Metaxas with Nguyen to obtain the invention as specified in
claim 1.

5.   Claims 2-11 are rejected under 35 U.S.C. 103(a) as being
unpatentable over Nguyen (US Patent 5,892,851) in view of
Metaxas (US Patent 6,307,978 B1) and Shiau (US Patent
5,880,857).

Regarding claim 2: Nguyen discloses dividing the error
word for each pixel in the first group (figure 5(100) of Nguyen)
into a first and second portion (column 3, lines 21-25 of
Nguyen). The error word is diffused to other pixels using
Floyd-Steinberg error diffusion (column 3, lines 21-25 of
Nguyen), which diffuses the error word in portions (column 4,
lines 27-32 of Nguyen). The process of error diffusion adds
said first and second error words to image data for a first
(figure 3(360) of Nguyen) and second pixel (figure 3(370) of
Nguyen) in the next row of pixels (figure 3 and column 3, lines
21-25 of Nguyen). As defined in the art, error diffusion
requires that the weighted, diffused errors be added to the
appropriate pixels in order to propagate the thresholding error
for each pixel.

Nguyen in view of Metaxas does not disclose expressly
generating a pseudo-random number; subtracting said pseudo-
random number from said first portion to produce a first
modified error word; and adding said pseudo-random number to
said second portion to produce a second modified error word.

Shiau discloses generating a pseudo-random number (column
5, lines 15-18 of Shiau); and adding said pseudo-random number
to image values (column 5, lines 29-32 of Shiau). The pseudo-
random number can be positive or negative (column 5, lines 17-18

of Shiau). The addition of a negative pseudo-random number is
the same as the subtraction of a positive pseudo-random number
of the same magnitude.

Nguyen in view of Metaxas is combinable with Shiau because
they are from the same field of endeavor, namely error diffusion
of image data. At the time of the invention, it would have been
obvious to a person of ordinary skill in the art to subtract a
pseudo-random number from said first portion, thus producing a
first modified error word; and add said pseudo-random number to
said second portion, thus producing a second modified error
word. If said pseudo-random number is subtracted from said
first portion, said pseudo-random number would need to be added
to said second portion since, as is well known in the art, the
total weights from an error diffusion filter need to add up to
about 1, but no more than 1, in order to maintain numerical
stability. The motivation for doing so would have been to
defeat visual artifacts of a regular and deterministic nature
(column 1, line 66 to column 2, line 1 of Shiau). Therefore, it
would have been obvious to combine Shiau with Nguyen in view of
Metaxas to obtain the invention as specified in claim 2.

Regarding claim 3: Nguyen discloses that said first
modified error word is added to image pixel data for a pixel
(figure 3(360) of Nguyen) directly below the pixel (figure 3
(310) of Nguyen) generating the error signal (column 3, lines
21-25 of Nguyen). The application of error diffusion (column 3,
lines 21-25 of Nguyen) implies that a weighted error word, such
as said first modified error word, is added to a corresponding
pixel since, as is well known in the art, this is the basic
process of error diffusion.

Regarding claim 4: Nguyen discloses that said second
modified error word is added to image pixel data for a pixel
(figure 3(370) of Nguyen) directly below and to the right of the
pixel (figure 3(310) of Nguyen) generating the error signal
(column 3, lines 21-25 of Nguyen).

Regarding claim 5: Nguyen discloses dividing the error
word for each pixel in the second group (figure 5(500) of
Nguyen) into a first (figure 6(620) of Nguyen) and second
portion (figure 6(610) of Nguyen) (column 4, lines 4-5 and lines
27-32 of Nguyen). The error word is diffused to other pixels
using a modified Floyd-Steinberg error diffusion (column 4,
lines 27-29 of Nguyen), which diffuses the error word in
portions (column 4, lines 27-32 of Nguyen). For said second
group, the error filter is modified from what is shown in figure
3 to redistribute the error diffusion that would normally go
from figure 3(310) to figure 3(330) of Nguyen (column 3, lines
59-62 of Nguyen). The process of error diffusion adds said
first error word to image data for a pixel (figure 3(360) of
Nguyen) in the next row of pixels (figure 3 and column 3, lines
21-25 of Nguyen). Since each segment of a row is processed in
parallel by rows (column 3, lines 55-59 of Nguyen), said second
error word is added to image data for a pixel (figure 3(370) of
Nguyen) in said group of pixels to be processed next (figure 5
and column 3, lines 21-25 of Nguyen). As can be seen in figure
5 of Nguyen, the pixel to which said second error word is added
(figure 3(370) of Nguyen) is in the segment which is below the
segment that is the immediate right of the last pixel (figure 3
(310) of Nguyen), and is thus in said group of pixels to be
processed next.

Nguyen in view of Metaxas does not disclose expressly generating a pseudo-random number; subtracting said pseudo-random number from said first portion to produce a first modified error word; and adding said pseudo-random number to said second portion to produce a second modified error word.

Shiau discloses generating a pseudo-random number (column 5, lines 15-18 of Shiau); and adding said pseudo-random number to image values (column 5, lines 29-32 of Shiau). The pseudo-random number can be positive or negative (column 5, lines 17-18 of Shiau). The addition of a negative pseudo-random number is the same as the subtraction of a positive pseudo-random number of the same magnitude.

Nguyen in view of Metaxas is combinable with Shiau because they are from the same field of endeavor, namely error diffusion of image data. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to subtract a pseudo-random number from said first portion, thus producing a first modified error word; and add said pseudo-random number to said second portion, thus producing a second modified error word. If said pseudo-random number is subtracted from said first portion, said pseudo-random number would need to be added to said second portion since, as is well known in the art, the total weights from an error diffusion filter need to add up to about 1, but no more than 1, in order to maintain numerical stability. The motivation for doing so would have been to defeat visual artifacts of a regular and deterministic nature (column 1, line 66 to column 2, line 1 of Shiau). Therefore, it would have been obvious to combine Shiau with Nguyen in view of Metaxas to obtain the invention as specified in claim 5.

Regarding claim 6: The arguments regarding claim 5 are incorporated herein. As stated, the pseudo-random number can be positive or negative (column 5, lines 17-18 of Shiau); and the addition of a negative pseudo-random number is the same as the subtraction of a positive pseudo-random number of the same magnitude. Therefore, adding said pseudo random number to said first portion, as stated in claim 6, performs the same operations as adding a negative pseudo random number to said first portion, which is the subtraction stated in claim 5. Likewise, adding a negative pseudo random number, which is the subtraction stated in claim 6, to said second portion performs the same operations as adding a pseudo random number to said second portion, as stated in claim 5. Furthermore, if said pseudo-random number is added to said first portion, said pseudo-random number would need to be subtracted from said second portion since, as is well known in the art, the total weights from an error diffusion filter need to add up to about 1, but no more than 1, in order to maintain numerical stability.

Regarding claim 7: Nguyen discloses dividing the error word for each pixel in the first group (figure 5(100) of Nguyen) into a first and second portion (column 3, lines 21-25 of Nguyen). The error word is diffused to other pixels using Floyd-Steinberg error diffusion (column 3, lines 21-25 of Nguyen), which diffuses the error word in portions (column 4, lines 27-32 of Nguyen). The process of error diffusion adds said first and second error words to image data for a first (figure 3(360) of Nguyen) and second pixel (figure 3(370) of Nguyen) in the next row of pixels (figure 3 and column 3, lines 21-25 of Nguyen).

Nguyen in view of Metaxas does not disclose expressly generating a first and second pseudo-random number; adding said first pseudo-random number to said first portion to produce a first modified error word; and adding said second pseudo-random number to said second portion to produce a second modified error word.

Shiau discloses generating a plurality of pseudo-random numbers (column 5, lines 15-18 of Shiau); and adding said pseudo-random numbers to image values (column 5, lines 29-32 of Shiau).

Nguyen in view of Metaxas is combinable with Shiau because they are from the same field of endeavor, namely error diffusion of image data. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to add the first of a plurality of pseudo-random numbers to said first portion, thus producing a first modified error word; and add the second of a plurality of pseudo-random numbers to said second portion, thus producing a second modified error word. The motivation for doing so would have been to defeat visual artifacts of a regular and deterministic nature (column 1, line 66 to column 2, line 1 of Shiau). Therefore, it would have been obvious to combine Shiau with Nguyen in view of Metaxas to obtain the invention as specified in claim 7.

Regarding claim 8: Nguyen discloses dividing the error word for each pixel in the second group (figure 5(500) of Nguyen) into a first (figure 6(620) of Nguyen) and second portion (figure 6(610) of Nguyen) (column 4, lines 4-5 and lines 27-32 of Nguyen). The error word is diffused to other pixels using a modified Floyd-Steinberg error diffusion (column 4, lines 27-29 of Nguyen), which diffuses the error word in

portions (column 4, lines 27-32 of Nguyen). For said second
group, the error filter is modified from what is shown in figure
3 to redistribute the error diffusion that would normally go
from figure 3(310) to figure 3(330) of Nguyen (column 3, lines
59-62 of Nguyen). The process of error diffusion adds said
first error word to image data for a pixel (figure 3(360) of
Nguyen) in the next row of pixels (figure 3 and column 3, lines
21-25 of Nguyen). Since each segment of a row is processed in
parallel by rows (column 3, lines 55-59 of Nguyen), said second
error word is added to image data for a pixel (figure 3(370) of
Nguyen) in said group of pixels to be processed next (figure 5
and column 3, lines 21-25 of Nguyen). As can be seen in figure
5 of Nguyen, the pixel to which said second error word is added
(figure 3(370) of Nguyen) is in the segment which is below the
segment to the immediate right of the last pixel (figure 3(310)
of Nguyen), and is thus in said group of pixels to be processed
next.

Nguyen in view of Metaxas does not disclose expressly
generating a first and second pseudo-random number; adding said
first pseudo-random number to said first portion to produce a
first modified error word; and adding said second pseudo-random
number to said second portion to produce a second modified error
word.

Shiau discloses generating a plurality of pseudo-random
numbers (column 5, lines 15-18 of Shiau); and adding said
pseudo-random numbers to image values (column 5, lines 29-32 of
Shiau).

Nguyen in view of Metaxas is combinable with Shiau because
they are from the same field of endeavor, namely error diffusion
of image data. At the time of the invention, it would have been

obvious to a person of ordinary skill in the art to add the first of a plurality of pseudo-random numbers to said first portion, thus producing a first modified error word; and add the second of a plurality of pseudo-random numbers to said second portion, thus producing a second modified error word. The motivation for doing so would have been to defeat visual artifacts of a regular and deterministic nature (column 1, line 66 to column 2, line 1 of Shiau). Therefore, it would have been obvious to combine Shiau with Nguyen in view of Metaxas to obtain the invention as specified in claim 8.

Regarding claim 9: The arguments regarding claim 7 are incorporated herein. As stated, the pseudo-random number can be positive or negative (column 5, lines 17-18 of Shiau); and the addition of a negative pseudo-random number is the same as the subtraction of a positive pseudo-random number of the same magnitude. Therefore, adding a negative second pseudo random number, which is the subtraction stated in claim 9, to said second portion performs the same operations as adding a second pseudo random number to said second portion, as stated in claim 7. Furthermore, if both the first pseudo-random number and second pseudo-random number are positive and the first pseudo-random number is added to said first portion, then said second pseudo-random number should be subtracted from said second portion. As is well known in the art, the total weights from an error diffusion filter need to add up to about 1, but no more than 1, in order to maintain numerical stability. Subtracting the second pseudo-random number from said second portion will help achieve numerical stability.

Regarding claim 10: The arguments regarding claim 8 are incorporated herein. As stated, the pseudo-random number can be

positive or negative (column 5, lines 17-18 of Shiau); and the addition of a negative pseudo-random number is the same as the subtraction of a positive pseudo-random number of the same magnitude. Therefore, adding a negative second pseudo random number, which is the subtraction stated in claim 10, to said second portion performs the same operations as adding a second pseudo random number to said second portion, as stated in claim 8. Furthermore, if both the first pseudo-random number and second pseudo-random number are positive and the first pseudo-random number is added to said first portion, then said second pseudo-random number should be subtracted from said second portion. As is well known in the art, the total weights from an error diffusion filter need to add up to about 1, but no more than 1, in order to maintain numerical stability. Subtracting the second pseudo-random number from said second portion will help achieve numerical stability.

Regarding claim 11: The arguments regarding claim 8 are incorporated herein. As stated, the pseudo-random number can be positive or negative (column 5, lines 17-18 of Shiau); and the addition of a negative pseudo-random number is the same as the subtraction of a positive pseudo-random number of the same magnitude. Therefore, adding a negative first pseudo random number to said first portion, which is the subtraction stated in claim 11, performs the same operations as adding a first pseudo random number to said first portion, as stated in claim 8. Furthermore, if both the first pseudo-random number and second pseudo-random number are positive and the first pseudo-random number is subtracted from said first portion, then said second pseudo-random number should be added to said second portion. As is well known in the art, the total weights from an error

diffusion filter need to add up to about 1, but no more than 1, in order to maintain numerical stability. Adding the second pseudo-random number to said second portion will help achieve numerical stability.

6.   Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nguyen (US Patent 5,892,851) in view of Metaxas (US Patent 6,307,978 B1) and Delabastita (US Patent 6,118,513).

Regarding claim 12: Nguyen discloses a display system (figure 2 of Nguyen) comprising a controller (figure 2(200) of Nguyen) for receiving and processing pixelated image data (column 3, lines 5-10 of Nguyen). Said controller performs the method of claim 1, the arguments of which are incorporated herein.

Nguyen does not disclose expressly that said group of pixels to be processed next, which are abutted by said last pixel, are in said row of pixels; a light source for generating a beam of light along a first light path; and a light modulator for selectively modulating light along said first light path in response to image data signals from said controller.

Metaxas discloses a group of pixels to be processed next which are abutted by the last pixel of the group of pixels that are being processed (figure 3; figure 5; and column 4, lines 48-55 of Metaxas). Error diffusion processing is performed in a diagonal manner (figure 5 and column 4, lines 48-55 of Metaxas). Furthermore, a pixel is only processed after all of the pixels from which said pixel depends have been processed. Thus (referring to figure 5 of Metaxas), the first pixel of the first row of A_{K-1} is processed only after the last pixel of the first

row of A_K is processed.   Thus, the last pixel of the first group
of pixels to be processed abuts the group of pixels to be
processed next in said row of pixel.

Nguyen and Metaxas are combinable because they are from the
same field of endeavor, namely parallel error diffusion. At the
time of the invention, it would have been obvious to a person of
ordinary skill in the art to combine the parallel processing
method taught by Nguyen with the parallel processing method
taught by Metaxas. Thus combined, the individual area (such as
A_K in figure 5 of Metaxas) would be processed according to the
method of Nguyen while the overall image would be processed
according to the method of Metaxas. Therefore, the length "d"
in figure 5 of Metaxas would be broken into two or more sections
to be processed in parallel, such as shown in figure 5 of
Nguyen. When the last pixel of A_K in figure 5 of Metaxas is
processed, the next group to be processed, which is the first
group in the portion of A_{K-1} on the same row, is processed
according to the method of Metaxas. The motivation for doing so
would have been that the first pixel of the first group in A_{K-1}
cannot be processed until all of the pixels from which said
pixel depends have been processed (column 4, lines 18-20 of
Metaxas), which includes the last pixel of the last group in A_K.
Thus, processing the set of groups in A_K in figure 5 of Metaxas
in parallel (divided in accordance figure 5 of Nguyen) will
speed up the overall error diffusion processing. Since the set
of pixels in A_{K-1} must wait for the last pixel in A_K, if all the
pixels for one row of A_K are processed faster, then the
processing of A_{K-1} will occur sooner. Thus, while the processing
of A_K may cause a slight loss of accuracy owing to the fact that
the error between the parallel processed groups (according to

Nguyen) of a single row of A_K cannot be diffused between each
other, this is greatly outweighed by the tremendous increase in
speed. The combined system of Nguyen and Metaxas would be
faster than the system of Metaxas alone, owing to the increased
parallelism, and more accurate than the system of Nguyen alone,
owing to the propagation of error diffusion between areas such
as A_K and A_{K-1}. Therefore, it would have been obvious to combine
Metaxas with Nguyen.

Nguyen in view of Metaxas does not disclose expressly a
light source for generating a beam of light along a first light
path; and a light modulator for selectively modulating light
along said first light path in response to image data signals
from said controller.

Delabastita discloses a light source (figure 1(3) of
Delabastita) for generating a beam of light along a first light
path (column 3, lines 45-49 of Delabastita); and a light
modulator (figure 1(9) of Delabastita) for selectively
modulating light along said first light path in response to
image data signals from said controller (column 3, lines 49-55
of Delabastita). The hardware (figure 1(9) of Delabastita)
controls the rasterization of the image based on the received
density values (column 3, lines 49-55 of Delabastita). The
density values are processed using error diffusion (column 3,
line 67 to column 4, line 4 of Delabastita) and compared with a
threshold, which results in outputting either a 1 or a 0 (column
4, lines 4, lines 4-12 of Delabastita).

Nguyen in view of Metaxas is combinable with Delabastita
because they are from the same field of endeavor; namely image
data processing. At the time of the invention, it would have
been obvious to a person of ordinary skill in the art to use the

device of Delabastita to output the halftone data determined by
the system of Nguyen. The motivation for doing so would have
been to be able to copy the halftoned image data onto light-
sensitive materials (column 4, lines 45-50 of Delabastita).
Therefore, it would have been obvious to combine Delabastita
with Nguyen in view of Metaxas to obtain the invention as
specified in claim 12.

7.   Claims 13-20 are rejected under 35 U.S.C. 103(a) as being
unpatentable over Nguyen (US Patent 5,892,851) in view of
Metaxas (US Patent 6,307,978 B1), Delabastita (US Patent
6,118,513), and Shiau (US Patent 5,880,857).

Regarding claim 13: Nguyen discloses that said controller
(figure 2(200) of Nguyen) divides the error word for each pixel
in the first group (figure 5(100) of Nguyen) into a first and
second portion (column 3, lines 21-25 of Nguyen). The error
word is diffused to other pixels using Floyd-Steinberg error
diffusion (column 3, lines 21-25 of Nguyen), which diffuses the
error word in portions (column 4, lines 27-32 of Nguyen). The
process of error diffusion adds said first and second error
words to image data for a first (figure 3(360) of Nguyen) and
second pixel (figure 3(370) of Nguyen) in the next row of pixels
(figure 3 and column 3, lines 21-25 of Nguyen).

Nguyen in view of Metaxas and Delabastita does not disclose
expressly generating a pseudo-random number; subtracting said
pseudo-random number from said first portion to produce a first
modified error word; and adding said pseudo-random number to
said second portion to produce a second modified error word.

Shiau discloses generating a pseudo-random number (column
5, lines 15-18 of Shiau); and adding said pseudo-random number

to image values (column 5, lines 29-32 of Shiau). The pseudo-
random number can be positive or negative (column 5, lines 17-18
of Shiau). The addition of a negative pseudo-random number is
the same as the subtraction of a positive pseudo-random number
of the same magnitude.

Nguyen in view of Metaxas and Delabastita is combinable
with Shiau because they are from the same field of endeavor,
namely image data processing. At the time of the invention, it
would have been obvious to a person of ordinary skill in the art
to have said controller subtract a pseudo-random number from
said first portion, thus producing a first modified error word;
and add said pseudo-random number to said second portion, thus
producing a second modified error word. If said pseudo-random
number is subtracted from said first portion, said pseudo-random
number would need to be added to said second portion since, as
is well known in the art, the total weights from an error
diffusion filter need to add up to about 1, but no more than 1,
in order to maintain numerical stability. The motivation for
doing so would have been to defeat visual artifacts of a regular
and deterministic nature (column 1, line 66 to column 2, line 1
of Shiau). Therefore, it would have been obvious to combine
Shiau with Nguyen in view of Metaxas and Delabastita to obtain
the invention as specified in claim 13.

Regarding claim 14: Nguyen discloses that said controller
(figure 2(200) of Nguyen) divides the error word for each pixel
in the second group (figure 5(500) of Nguyen) into a first
(figure 6(620) of Nguyen) and second portion (figure 6(610) of
Nguyen) (column 4, lines 4-5 and lines 27-32 of Nguyen). The
error word is diffused to other pixels using a modified Floyd-
Steinberg error diffusion (column 4, lines 27-29 of Nguyen),

which diffuses the error word in portions (column 4, lines 27-32
of Nguyen). For said second group, the error filter is modified
from what is shown in figure 3 to redistribute the error
diffusion that would normally go from figure 3(310) to figure 3
(330) of Nguyen (column 3, lines 59-62 of Nguyen). The process
of error diffusion adds said first error word to image data for
a pixel (figure 3(360) of Nguyen) in the next row of pixels
(figure 3 and column 3, lines 21-25 of Nguyen). Since each
segment of a row is processed in parallel by rows (column 3,
lines 55-59 of Nguyen), said second error word is added to image
data for a pixel (figure 3(370) of Nguyen) in said group of
pixels to be processed next (figure 5 and column 3, lines 21-25
of Nguyen). As can be seen in figure 5 of Nguyen, the pixel to
which said second error word is added (figure 3(370) of Nguyen)
is in the segment which is below the segment to the immediate
right of the last pixel (figure 3(310) of Nguyen), and is thus
in said group of pixels to be processed next.

Nguyen in view of Metaxas and Delabastita does not disclose
expressly generating a pseudo-random number; subtracting said
pseudo-random number from said first portion to produce a first
modified error word; and adding said pseudo-random number to
said second portion to produce a second modified error word.

Shiau discloses generating a pseudo-random number (column
5, lines 15-18 of Shiau); and adding said pseudo-random number
to image values (column 5, lines 29-32 of Shiau). The pseudo-
random number can be positive or negative (column 5, lines 17-18
of Shiau). The addition of a negative pseudo-random number is
the same as the subtraction of a positive pseudo-random number
of the same magnitude.

Nguyen in view of Metaxas and Delabastita is combinable
with Shiau because they are from the same field of endeavor,
namely image data processing. At the time of the invention, it
would have been obvious to a person of ordinary skill in the art
to have said controller subtract a pseudo-random number from
said first portion, thus producing a first modified error word;
and add said pseudo-random number to said second portion, thus
producing a second modified error word. If said pseudo-random
number is subtracted from said first portion, said pseudo-random
number would need to be added to said second portion since, as
is well known in the art, the total weights from an error
diffusion filter need to add up to about 1, but no more than 1,
in order to maintain numerical stability. The motivation for
doing so would have been to defeat visual artifacts of a regular
and deterministic nature (column 1, line 66 to column 2, line 1
of Shiau). Therefore, it would have been obvious to combine
Shiau with Nguyen in view of Metaxas and Delabastita to obtain
the ·invention as specified in claim 14.

Regarding claim 15: The arguments regarding claim 14 are
incorporated herein. As stated, the pseudo-random number can be
positive or negative (column 5, lines 17-18 of Shiau); and the
addition of a negative pseudo-random number is the same as the
subtraction of a positive pseudo-random number of the same
magnitude. Therefore, adding said pseudo random number to said
first portion, as stated in claim 15, performs the same opera-
tions as adding a negative pseudo random number to said first
portion, which is the subtraction stated in claim 14. Likewise,
adding a negative pseudo random number, which is the subtraction
stated in claim 15, to said second portion performs the same
operations as adding a pseudo random number to said second

portion, as stated in claim 14. Furthermore, if said pseudo-random number is added to said first portion, said pseudo-random number would need to be subtracted from said second portion since, as is well known in the art, the total weights from an error diffusion filter need to add up to about 1, but no more than 1, in order to maintain numerical stability.

Regarding claim 16: Nguyen discloses that said controller (figure 2(200) of Nguyen) divides the error word for each pixel in the first group (figure 5(100) of Nguyen) into a first and second portion (column 3, lines 21-25 of Nguyen). The error word is diffused to other pixels using Floyd-Steinberg error diffusion (column 3, lines 21-25 of Nguyen), which diffuses the error word in portions (column 4, lines 27-32 of Nguyen). The process of error diffusion adds said first and second error words to image data for a first (figure 3(360) of Nguyen) and second pixel (figure 3(370) of Nguyen) in the next row of pixels (figure 3 and column 3, lines 21-25 of Nguyen).

Nguyen in view of Metaxas and Delabastita does not disclose expressly generating a first and second pseudo-random number; adding said first pseudo-random number to said first portion to produce a first modified error word; and adding said second pseudo-random number to said second portion to produce a second modified error word.

Shiau discloses generating a plurality of pseudo-random numbers (column 5, lines 15-18 of Shiau); and adding said pseudo-random numbers to image values (column 5, lines 29-32 of Shiau).

Nguyen in view of Metaxas and Delabastita is combinable with Shiau because they are from the same field of endeavor, namely image data processing. At the time of the invention, it

would have been obvious to a person of ordinary skill in the art
to use said controller to add the first of a plurality of
pseudo-random numbers to said first portion, thus producing a
first modified error word; and add the second of a plurality of
pseudo-random numbers to said second portion, thus producing a
second modified error word. The motivation for doing so would
have been to defeat visual artifacts of a regular and determin-
istic nature (column 1, line 66 to column 2, line 1 of Shiau).
Therefore, it would have been obvious to combine Shiau with
Nguyen in view of Metaxas and Delabastita to obtain the
invention as specified in claim 16.

Regarding claim 17: Nguyen discloses that said controller
(figure 2(200) of Nguyen) divides the error word for each pixel
in the second group (figure 5(500) of Nguyen) into a first
(figure 6(620) of Nguyen) and second portion (figure 6(610) of
Nguyen) (column 4, lines 4-5 and lines 27-32 of Nguyen). The
error word is diffused to other pixels using a modified Floyd-
Steinberg error diffusion (column 4, lines 27-29 of Nguyen),
which diffuses the error word in portions (column 4, lines 27-32
of Nguyen). For said second group, the error filter is modified
from what is shown in figure 3 to redistribute the error
diffusion that would normally go from figure 3(310) to figure 3
(330) of Nguyen (column 3, lines 59-62 of Nguyen). The process
of error diffusion adds said first error word to image data for
a pixel (figure 3(360) of Nguyen) in the next row of pixels
(figure 3 and column 3, lines 21-25 of Nguyen). Since each
segment of a row is processed in parallel by rows (column 3,
lines 55-59 of Nguyen), said second error word is added to image
data for a pixel (figure 3(370) of Nguyen) in said group of
pixels to be processed next (figure 5 and column 3, lines 21-25

of Nguyen). As can be seen in figure 5 of Nguyen, the pixel to
which said second error word is added (figure 3(370) of Nguyen)
is in the segment which is below the segment to the immediate
right of the last pixel (figure 3(310) of Nguyen), and is thus
in said group of pixels to be processed next.

Nguyen in view of Metaxas and Delabastita does not disclose
expressly generating a first and second pseudo-random number;
adding said first pseudo-random number to said first portion to
produce a first modified error word; and adding said second
pseudo-random number to said second portion to produce a second
modified error word.

Shiau discloses generating a plurality of pseudo-random
numbers (column 5, lines 15-18 of Shiau); and adding said
pseudo-random numbers to image values (column 5, lines 29-32 of
Shiau).

Nguyen in view of Metaxas and Delabastita is combinable
with Shiau because they are from the same field of endeavor,
namely image data processing. At the time of the invention, it
would have been obvious to a person of ordinary skill in the art
to have said controller add the first of a plurality of pseudo-
random numbers to said first portion, thus producing a first
modified error word; and add the second of a plurality of
pseudo-random numbers to said second portion, thus producing a
second modified error word. The motivation for doing so would
have been to defeat visual artifacts of a regular and determin-
istic nature (column 1, line 66 to column 2, line 1 of Shiau).
Therefore, it would have been obvious to combine Shiau with
Nguyen in view of Metaxas and Delabastita to obtain the
invention as specified in claim 17.

Regarding claim 18: The arguments regarding claim 16 are incorporated herein. As stated, the pseudo-random number can be positive or negative (column 5, lines 17-18 of Shiau); and the addition of a negative pseudo-random number is the same as the subtraction of a positive pseudo-random number of the same magnitude. Therefore, adding a negative second pseudo random number, which is the subtraction stated in claim 18, to said second portion performs the same operations as adding a second pseudo random number to said second portion, as stated in claim 16. Furthermore, if both the first pseudo-random number and second pseudo-random number are positive and the first pseudo-random number is added to said first portion, then said second pseudo-random number should be subtracted from said second portion. As is well known in the art, the total weights from an error diffusion filter need to add up to about 1, but no more than 1, in order to maintain numerical stability. Subtracting the second pseudo-random number from said second portion will help achieve numerical stability.

Regarding claim 19: The arguments regarding claim 17 are incorporated herein. As stated, the pseudo-random number can be positive or negative (column 5, lines 17-18 of Shiau); and the addition of a negative pseudo-random number is the same as the subtraction of a positive pseudo-random number of the same magnitude. Therefore, adding a negative second pseudo random number, which is the subtraction stated in claim 19, to said second portion performs the same operations as adding a second pseudo random number to said second portion, as stated in claim 17. Furthermore, if both the first pseudo-random number and second pseudo-random number are positive and the first pseudo-random number is added to said first portion, then said second

pseudo-random number should be subtracted from said second portion. As is well known in the art, the total weights from an error diffusion filter need to add up to about 1, but no more than 1, in order to maintain numerical stability. Subtracting the second pseudo-random number from said second portion will help achieve numerical stability.

Regarding claim 20: The arguments regarding claim 17 are incorporated herein. As stated, the pseudo-random number can be positive or negative (column 5, lines 17-18 of Shiau); and the addition of a negative pseudo-random number is the same as the subtraction of a positive pseudo-random number of the same magnitude. Therefore, adding a negative first pseudo random number to said first portion, which is the subtraction stated in claim 20, performs the same operations as adding a first pseudo random number to said first portion, as stated in claim 17. Furthermore, if both the first pseudo-random number and second pseudo-random number are positive and the first pseudo-random number is subtracted from said first portion, then said second pseudo-random number should be added to said second portion. As is well known in the art, the total weights from an error diffusion filter need to add up to about 1, but no more than 1, in order to maintain numerical stability. Adding the second pseudo-random number to said second portion will help achieve numerical stability.

Conclusion

8. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

    a. Webb et al., US Patent 5,553,165, Patented 03 September 1996, Filed 04 January 1994.

    b.   C.S. Chan, US Patent 5,031,050, Patented 09 July 1991,
    Filed 26 February 1990.

    Any inquiry concerning this communication or earlier
communications from the examiner should be directed to James A.
Thompson whose telephone number is 571-272-7441. The examiner
can normally be reached on 8:30AM-5:00PM.

    If attempts to reach the examiner by telephone are
unsuccessful, the examiner's supervisor, David K. Moore can be
reached on 571-272-7437. The fax phone number for the
organization where this application or proceeding is assigned is
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                                        James A. Thompson
                                        Examiner
                                        Art Unit 2624

10 January 2006

THOMAS D.